The Economics of Rafting Vs. Barging as Means of Transporting Logs in Southeast Alaska Waters

THE ECONOMICS OF RAFTING VS. BARGING AS MEANS OF TRANSPORTING LOGS IN SOUTHEAST ALASKA WATERS

by

Kenneth E. Beil

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Respectfully submitted April 20, 1974.

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THE ECONOMICS OF RAFTING VS. BARGING AS MEANS OF TRANSPORTING LOGS IN SOUTHEAST ALASKA WATERS

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SECTION I.

INTRODUCTION

A. Background and Purpose of Study

Since the beginning of man's use of trees to provide firewood and shelter, no doubt the inherent ability of wood to float was used by man to transport tree products from the forest to the place of use.

In the initial development of the timber industry in the relatively protected inland marine waters of Puget Sound in coastal Washington State, trees were felled into the water, bucked into logs by hand, and towed to a mill by rowboat. Soon logs were brought to the water by other methods and a group of logs was formed into a raft by an encirclement of logs chained together and towed by a powered boat to the mill.

Since that time, great volumes of logs from the tremendous coastal forests of Washington, British Columbia, and southeast Alaska have been moved to mills in raft form on the generally protected marine waters.

Recent innovations include the strapping of logs into bundles, which lowers log losses from low floaters and allows for a greater volume of logs to occupy the same amount of water area as a flat raft. Self-dumping barges have been developed and extensively used in British Columbia because they provide less expensive transportation over long distances and can travel over open ocean waters such as the Pacific Ocean off the West Coast of Vancouver Island.

Recently, concern has been expressed about the environmental impact of log rafting and storage in the marine waters of southeast Alaska. In order to avoid such impact, if it is adverse and significant,

land-to-land (loading from land to barge and off-loading from barge to land) movement of logs by barge would be the only alternative. Partial barging systems such as water-barge-land or land-barge-water may minimize but only partially answer damage to the marine environment objections. Therefore, this study examines the relative economics of the two methods of transportation, rafting and land-to-land barging, as well as their impact on the environment and provides an estimate of the relative social costs of such impact.

B. The Industry in Southeast Alaska

The forest industry in southeast Alaska, defined as roughly from Dixon Entrance to Skagway, is by far the major industry and source of employment in the area of study. There are two existing pulp mills and a third is scheduled. Ketchikan Pulp Company (KPC) is located on Ward Cove a few miles north of Ketchikan. It has associated sawmills in Ketchikan, at Metlakatla on Annette Island, and at Klawock on Prince of Wales Island. Alaska Lumber & Pulp Co. (ALP) is located at Silver Bay a few miles from Sitka and it has associated sawmills at Wrangell. Champion International is the holder of the Juneau Unit Timber Sale which has been held up as the result of court action by various environmental activist groups. If the sale proceeds, company plans are apparently to build a pulp mill and sawmill complex at Echo Cove north of Juneau. Other significant forest industries are the export sawmills located at Haines - Alaska Forest Products, Inc. and Schnabel Lumber Company. There are also a number of small mills which provide lumber for local markets. With minor exceptions, these mills operate on publicly-owned timber, both federal and state, on which is imposed the requirement that primary manufacture take place in Alaska.

According to 1970 statistics, *"the Tongass National Forest (including the Yakutat area) supports the largest industry in southeast Alaska, the third largest industry in the State of Alaska, the only year-round natural resource industry in southeast Alaska, and ranks as the number one resource industry in the State of Alaska as an employer of year-round labor. Of the forty-two thousand people who make their homes in southeast Alaska, approximately seventeen thousand are employed. Fully fifty per cent of this employment is either directly or indirectly dependent upon the timber industry."* (Reference 19)

The annual log volume requirement for the timber industry in southeast Alaska is approximately 660 MMBF (million board feet), although this volume is not always produced. Most of this is harvested from the Tongass National Forest but a small volume is harvested from state and private lands. The importance of this volume to the economy of southeast Alaska (the timber from public ownership must receive primary manufacture in Alaska) is indicated by the following quote from the Draft Environmental Statement, Ketchikan Pulp Company Timber Sale, 1974-79 Operating Period (Ref. No. 67). Figures in brackets are said to be corrections found in the Final Environmental Statement.

"Employment statistics (Alaska Department of Labor 1972. Alaska 1971 Industry and Area Work Force Estimates) show there are 100 direct employment jobs supported by the industry for each 18 [24.8] million board feet harvested. National statistics (verified locally) show there are an additional 79 service jobs created by each 100 jobs of direct employment [2.38 indirect to 1 direct]. With each additional 100 jobs created, there is a need for one additional retail outlet.

Currently, each 100 jobs in the timber industry produces a payroll (1972 average) of $1,482,500 [$1,386,000]. For practical purposes, this is $1,500,000 of annual payroll from industry, for each 18 million board feet of timber harvested. This, plus the payroll from support jobs, is approximately 2.4 [4.1] million dollars into the local economy annually."

In the Ketchikan area, it is said that 75% of the total employment is related to the timber industry. (Reference 67)

As the above statistics indicate, the economy of the area is heavily dependent upon the timber industry. It is only since the establishment of the timber industry that year-round employment is available and that towns have become something more than sleepy villages with no stable economic base. The U.S. Forest Service and the State of Alaska are currently committed to managing thepublic forest, the major source of timber, on a sustained yield basis. For the purposes of this study, it is assumed that production of logs for the forest industry is a reasonable use of the timber resources in southeast Alaska.

Without doubt, the economy and the employment in southeast Alaska are tied directly to the timberindustry. At the same time, it is imperative for the industry to minimize damage to the environment subject to the constraints of employment and well-being of the economy.

C. Scope of Study

There have been questions raised about the effect of the marine environment by the transportation of logs from producing areas to mills by means of towing rafted logs floating in the water. It is alleged that logs lost in towing or storage pollute the beaches and are a hazard to navigation; that harm is done to marine organisms and water where logs are put in or removed from the water; and that the environment would be less damaged by land-to-land barging of logs.

This study is to investigate the economics of log rafting versus log barging and to explore the extent and implication of impacts on the marine environment from data available in previous published studies and from interviews.

Key questions set forth by the U. S. Forest Service Pacific Northwest Experiment Station in its study plan are:

1. *Is it more economical for the timber producer to transport logs by barging or rafting in southeast Alaska waters?*

2. *What costs of barging and rafting are external to the timber producer and are they sufficient to warrant the use of one system or the other?*

SECTION II

SUMMARY AND CONCLUSIONS

A. The timber industry is very important to the economy of Southeast Alaska and comprises, by far, the largest industry there as well as being the only year-round natural resource industry. Fifty percent of employment is related to the timber industry.

B. Water transport of logs is the only possible method of transportation in the island geography of Southeast Alaska. Logs have customarily been floated in rafts from producing points to water storage areas and to mills. A very limited amount of barging has taken place in Alaska, but a considerable amount takes place in coastal British Columbia.

C. There has been comment by environmentalists that log rafting in Alaska causes great damage to the marine environment and, assuming that the timber industry will continue to exist, that keeping logs out of the water is the best method to minimize or eliminate this damage. Only land storage of logs and land-to-land barging would accomplish this. Canada's barging is almost exclusively through use of self-dumping barges - a system that would not be an improvement on log-rafting.

D. Two key questions were set forth in the Forest Service Study Plan. The questions and conclusions are:

1. *Is it more economical for the timber producer to transport logs by barging or rafting in Southeast Alaska waters?*

   Rafting utilizes the inherent ability of logs to float. Capital and operating costs associated with this form of transportation are low and the system serves its purpose well.

   Very little is directly known about land-to-land barging as there is practically no movement of logs by this method. It is clear, however, that capital and operating costs for transportation would be very high as well as for the facilities needed for loading, unloading and log storage.

   Without any doubt it is more economical to transport logs by rafting than by land-to-land barging. It is estimated that barging costs for the average towing distance of about 100 miles would be at least three times rafting costs and could be considerably more.

On tows of about 200 miles or more, and where open waters are traveled, transportation by barge, loading from and unloading into the water, could be economically comparable to rafting. This method would not, however, be any kinder to the marine environment than rafting.

2. *What costs of barging and rafting are external to the timber producer and are they sufficient to warrant the use of one system or the other?*

Five general cost areas were considered which include several that are not exactly external to the timber producer. These areas are log losses, volume losses, stealing, damage to the environment and damage from loose logs or towing rafts or barges.

Log losses from rafting have been greatly eliminated by bundling of logs and the breaking of bundles on dry decks. Nevertheless, some losses occur and it is estimated to be about 0.1% of total annual cut. About 80% of the loss is recovered. Loss and recovery costs are estimated to be about 20¢/MBF. There would not ordinarily be any loss from land-to-land barging, but casualty losses sometimes occur.

Volume losses from marine borers can be controlled by careful scheduling of water storage. Ambrosia beetle damage in both rafting and barging is not significant. There could be subtle volume loss through diminished use of cull sawlogs for pulp because of uneconomic transportation cost if barging was required.

Stealing and damage from loose logs or towing of rafts or barges is not considered significant.

Damage to the marine environment does occur from rafting. Studies made to date indicate that smothering of benthic (bottom) organisms can occur from bark deposits at dump sites and that these deposits can result in an increased biological oxygen demand. Also that leachates from some tree species are toxic to some marine organisms. However, these studies indicate that these conditions are localized and there is evidence that their effect is not irreversible.

No one has calculated the extent or value of losses from this damage and, at this point in time, there does not appear to be a good method of doing so. It is estimated that about 0.28% of cove and bay area in Southeast Alaska waters is affected by rafting activities. Assuming that there is a direct relationship between area of coves and bays and the value of fisheries, fisheries are damaged to the extent of approximately $180,000 per year which amounts to a cost of 30¢/MBF based on yearly log production.

While damage to the environment is real, it is not considered to be sufficiently significant to warrant the use of land-to-land barging over rafting. Besides, it is clear that barging would create its own brand of damage which may be as significant as rafting.

E. Further studies on the impact on marine environments by log rafting are scheduled by both U.S. and B.C. governments. These should result in recommendations for improved log handling methods.

F. There appears to be no compelling environmental reason to favor land-to-land barging over rafting if careful handling methods are followed, but there are very compelling economic reasons to favor rafting over barging.

G. It is estimated that if land-to-land barging of logs was required, the additional cost of transporting logs would be $14.00/MBF or more, or, based on a production of 600 MMBF, the annual sum of $8,400,000 or more.

SECTION III

LOG RAFTING

A. Description of Process

The inland marine waterways of southeast Alaska provide practically the only means of moving logs from producing areas to the mills. Only occasionally are timber harvesting operations carried out where there is road access to the mills.

It is the nature of the timber resource that commercial timber generally lies in valleys or in noncontinuous areas of various sizes. A truck road system is the most economical method to transport logs from large log volume production areas. Because of terrain or because some areas do not have enough volume to support the cost of a truck road system, other methods of transporting logs to marine waters are used. These methods may include yarding logs directly to the water with A-frame mounted on log rafts or transportation of logs, produced by other means, to water by skidding with a tractor or, more commonly, with rubber-tired skidder.

KPC, for instance, receives logs each year from about five relatively large truck operations which have a range of production from 25 MMBF to 80 MMBF. In addition, it receives logs from five to fifteen other smaller truck, A-frame or skidder operations. Many of these small operations may produce only 0.5 MMBF to the water at one location and use several locations during the course of a year's operations. Even the large operations may have several dump sites. ALP logging operations are similar. The mills at Haines receive a substantial volume of their logs directly by truck from state timber sales in the Haines area. Their timber requirements are relatively small, so, in turn, their production areas accessible by water would tend to be relatively small.

The period of use for most dump sites is one to five years except for exceptionally large truck operations such as KPC's Thorne Bay camp on Price of Wales Island. Dump sites must be located in protected bays and coves where sufficient water is available to float log bundles at least during usual high tides. In the case of smaller operations particularly, the locations of dump sites are also influenced by rocky or severe terrain which is common to southeast Alaska islands. Because of low daily or total production, a barely adequate dump site may be tolerated because it is close to the log producing area and, as a result, expensive road construction may be held to a minimum.

At the dump sites, truck loads are strapped with steel strapping in order to form a bundle. Depending on truck bunk width, the bundles may be 8 to 10 feet in diameter, up to 48 to 52 feet long, and contain 7 to 12 MBF (thousand board feet). At logging locations where dry land sorting and storage is not available, logs are sorted by end use as they are

placed on the truck although there may be a minor amount of resorting at the dump site. The minimum number of sorts is four, consisting of a pulp sort, a hemlock sawmill sort, a spruce sawmill sort and a cedar sort. After the truckload is bundled, the load is lifted off the truck with some kind of A-frame set-up and placed in the water. Gentle handling is possible and should be or is required. Pulp logs may include cull sawlogs which contain 50% or more sound wood volume. These logs, because of their sawlog defects, must be handled carefully, as is possible in the rafting transportation concept. These are low value logs which will not support high production costs. Their use by the pulp mills provides a good means of extending the effective supply of logs for all uses.

Where dry land sorting and storage areas have been developed, such as KPC's Thorne Bay and ALP's Rowan and Corner Bay operations, logs are trucked in camp-run, sorted by log-stacker, and bundled before being placed in the water.

In some location, the volume of logs to be harvested is too small to support a truck operation or the terrain is too difficult for truck road construction. In these instances, logs may be yarded by A-frame directly to marine waters, where they are kept in a boom until enough logs are generated for bundling in the water. Or logs may be brought to a beach by rubber-tired skidder and made into bundles at low tide so that the bundles may float free at high tide.

Bundles of logs are then made into rafts, consisting usually of one of the log sorts. Production of small operations may have several log sorts, such as sawmill hemlock and sawmill spruce combined in one raft. Since the log sorts are separated as bundled logs, this provides a flexibility for small operations to move out their production. It is not difficult to resort bundles at mill receiving points. A raft consists of 70 to 90 bundles of logs contained within an enclosure of boomsticks chained together with boomchains. The dimensions of a raft are approximately 70 by 550 feet, and a raft may contain from 300 to 600 MBF depending upon the log sort it contains (pulp logs provide less volume and sawlogs provide more volume). Wire swifters are placed over the log bundles from one side of the raft to the other in order to preserve raft width and to minimize movement of the bundles within the raft. Boomsticks are manufactured from logs produced by the logging operations. Boomchains, wire swifters and strapping are supplied by the mills.

Rafts may be moved to nearby transfer points or storage areas, towed to winter storage areas, or towed directly to the mills.

Where log bundles are to be kept in storage for raft make-up or at a raft transfer point for a short period of time up to a month, the main requirement is protected waters. Where the storage period is longer, up to six to eight months for winter supply purposes, it is also preferable that logs go dry at low tide on a flat, firm beach and/or that the storage waters contain as much flowing fresh water as possible. This minimizes

damage from marine worms and borers. In general, winter supply storage areas are used many years.

For towing, several rafts are joined together for a combined volume of several million board feet. A great deal of flexibility in tow make-up is available. Pulp and sawmill rafts can be in the same tow and can easily be added to or removed from the tow as is appropriate.

Towing speed is generally one to two knots. Weather conditions dictate, of course, when tows can be made safely. Long stretches of open water such as Chatham Straits or Lynn Canal are particularly difficult. These waters can be safely used for towing for only about six months each year, or approximately May through October. Although towing companies consult weather forecasts before commencing a tow, unforeseen bad winds can occur, making it necessary to move to a protected area until weather conditions improve.

When log bundles are received at either pulp mill, the bundles are lifted intact and broken on a dry deck, thus eliminating any log loss from sinkers or low floaters. Log bundles received at sawmills are usually broken in the water. However, sawlog size and value is generally good and care is taken to avoid any loss of logs.

Because of short logging and and towing seasons (on some waters), the two major companies provide for storage facilities for 1/3 to 1/2 of their annual log production. These storage facilities must be within towing range all seasons of the year. Both companies have or shall have developed limited dry land storage. The sites for such storage are difficult to find and are expensive to develop.

Nevertheless, they provide an area where better sorting can take place and where the the higher value sawmill logs can be stored free from damage from marine worms and borers. The balance of the storage areas are protected water areas as previously described.

B. Costs

Obviously, since logs float (most of them, anyway), the capital cost of equipment other than tugboats necessary for water transportation of logs is very low. It consists of investments in boomchains, swifter wire, anchors in storage areas, piling and standing booms in receiving areas, and company boom boats. As all towing is contracted, there is no capital invested by the industry in tugboats.

The facilities for putting logs in the water and the makeup of rafts are a logging responsibility. The facilities at each mill for receiving logs are generally a mill cost, although perhaps both should be figured as a cost of transportation.

The facilities for placing logs in the water at truck operations vary greatly in cost according to land and water conditions and terrain at the dump site. Usually a bulkhead of logs is built out to where water depth is sufficient to float bundles. The bulkhead is filled with soil and rock to provide a level surface for trucks. An A-frame powered by an old yarding machine is generally used to lift the bundled logs off the truck bunk and place them gently in the water. When operations are complete, the A-frame and yarder are moved to the next site and the bulkhead area is abandoned. A few anchors provide the means for securing the made-up rafts until they are moved out. The anchors are generally recovered and used again, although a few are lost.

The facilities necessary for A-frame logging and beach-prepared bundles are more simple and less costly although more labor intensive than truck operations.

According to cost data collected by the U.S. Forest Service for selected log dump construction for a lift off operation in use during the years 1966-72, construction costs range from $3,000 to $114,000, although the average cost during this time would appear to be around $25,000 to $30,000. Based on the volume which has been produced over these dumps, the amortized construction cost is $0.20/MBF.

The U.S. Forest Service Timber Sale Preparation and Appraisal Handbook, 2409.22R10 amendment dated November, 1973, is quoted directly as follows:

> *F. Section 6. Dump, Bundle and Raft. This section covers the cost allowances for dumping, bundling and rafting operations found on various types of timber sales. The costs cover all bundling and rafting gear, labor, and supplies associated with this operation. Depreciation for dump machine, boom boats, boomstick drills, and other pieces of equipment is also included. There is no table adjustment from the Regional average for this cost allowance.*

*1. Truck Sale - Dump and Raft. The Regional average cost of *$3.55/MBF will be used for the Tongass N.F., and $4.39/MBF for the Chugach N.F.**

2. A-frame - Dump and Raft. The Regional average cost of $7.12/MBF will be used.

3. Tractor or Rubber-tired Swing - Dump and Raft. The Regional average dump and raft cost for A-frame operation will be used.

> *G. Section 7 - Towing and Barging. The movement of logs in Southeast Alaska presents an extremely complex picture. Logs do not move directly from dump to mill in many instances. Rerafting of logs from one manufacturing point to another is common. To reflect the costs of towing, log storage, reraft tows, tow insurance and barging, all of these costs have been collected on some 571,760 MBF of logs handled in base year 1971. The average cost of this handling is $3.94/MBF.*

The above is based on 1971 costs. Current costs on a similar basis are difficult to break out as the Forest Service data includes costs which are both logger and company inputs. However, the average handling cost of $3.94 may be updated by an inflation factor as follows:

$3.94 X 1.05 X 1.06 = $4.43

Both ALP and KPC provide strapping, boomchains and other rafting gear to loggers. The loggers generally provide the on-site facilities and labor. Both companies estimate their 1973 non-towing water transportation costs approximately as follows:

Rafting gear and strapping supplies	$1.25/MBF
Putting in dry storage and taking out	.20
Handling - anchors, raft repair, etc.	.30
Total	$1.75/MBF

Towing rates vary almost directly by distance on long tows. On short tows, the waters over which the tows are made also influence the rates. Both KPC and ALP take delivery of logs at the point they are put in the water and contract for the towing. KPC contracts almost exclusively with Boyer Towing Co., Inc., of Ketchikan and ALP with Samson Tug and Barge Co. of Sitka.

Data for the last five years of production, by distance towed, was gathered from KPC and ALP. This is presented in graph form in Figures 1 and 2 which show volume towed by 20-mile groupings. The graphs provide an illustration of dispersion of volume towed by distance groupings around the average tow distance. For KPC, the average tow distance is 100.4 miles and for ALP it is 109.7 miles. It is anticipated that these average tow distances will not change greatly in the future.

In regards to the longer tows, for KPC there was significant volume towed at the 160-mile distance. For ALP, there was significant volume towed in the 160 to 200-mile distance, although some volume was towed as far as 280 miles. The average of the 160 to 280-mile tows is 200 miles.

Boyer Towing, Inc. has contract rates per MBF net scale for tows from various points to Ward Cove or storage areas. For a 100-mile tow, the current rate, by interpolation, would be approximately $4.05/MBF. Samson Tug had a 1973 rate per mile for pulp of $0.0506/MBF and for sawlogs of $0.0416/MBF. The average, including both pulp and sawlogs, was said to be approximately $0.048/MBF. Short tows may have a higher rate because of local water conditions. Therefore, for a tow of 100 miles, the rate would be $4.80/MBF, which probably is representative of the more severe waters (Peril Straits), over which ALP's logs must be towed. A similar tow in Canada would apparently be in the $3.50/MBF range, although no direct rate information would be divulged by those contacted.

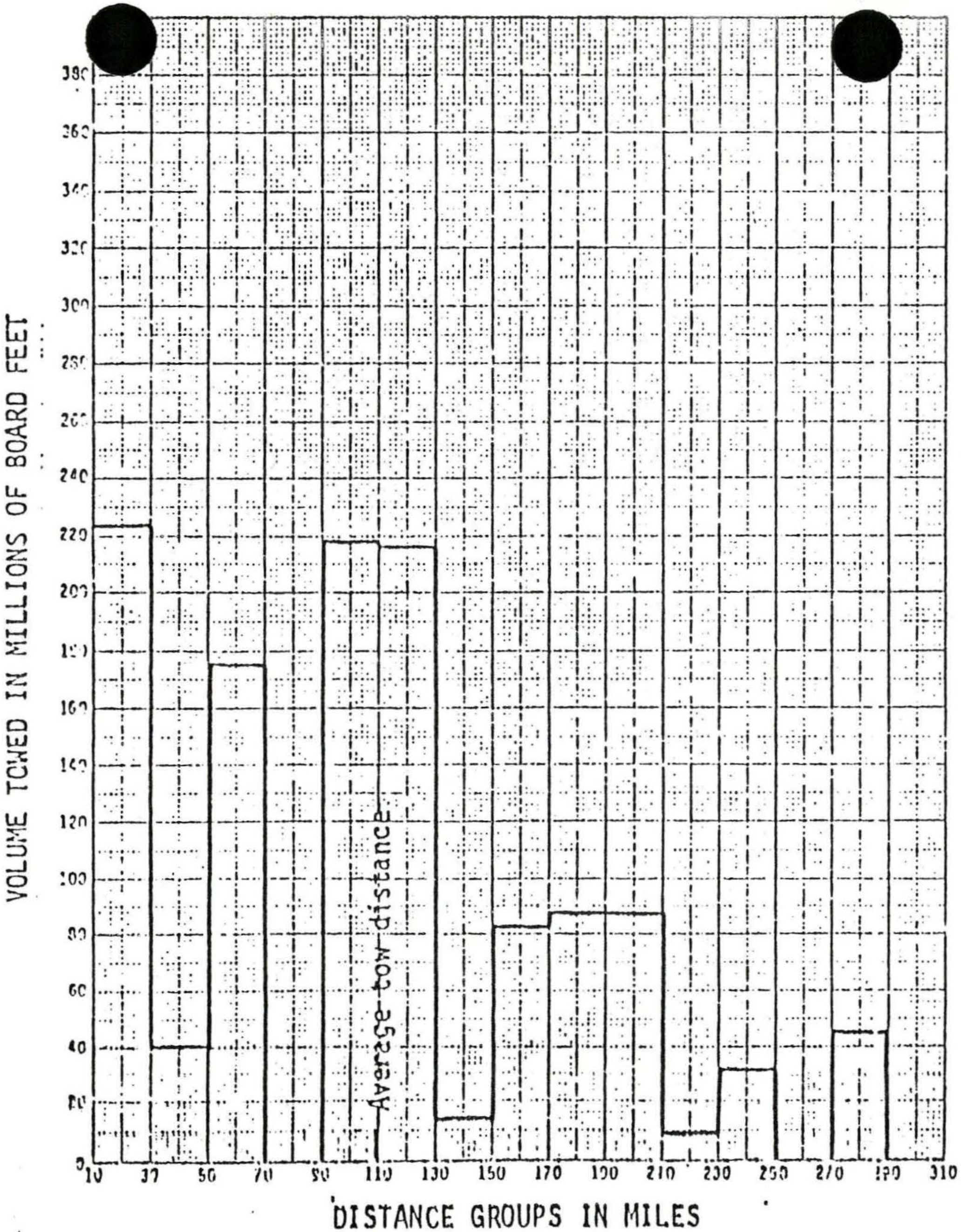

Figure 1. Alaska Lumber & Pulp Co., Inc. Log Volume Towed - 1969 Through 1973 - by Twenty Mile Distance Groups. Average Tow - 109.7 Miles.

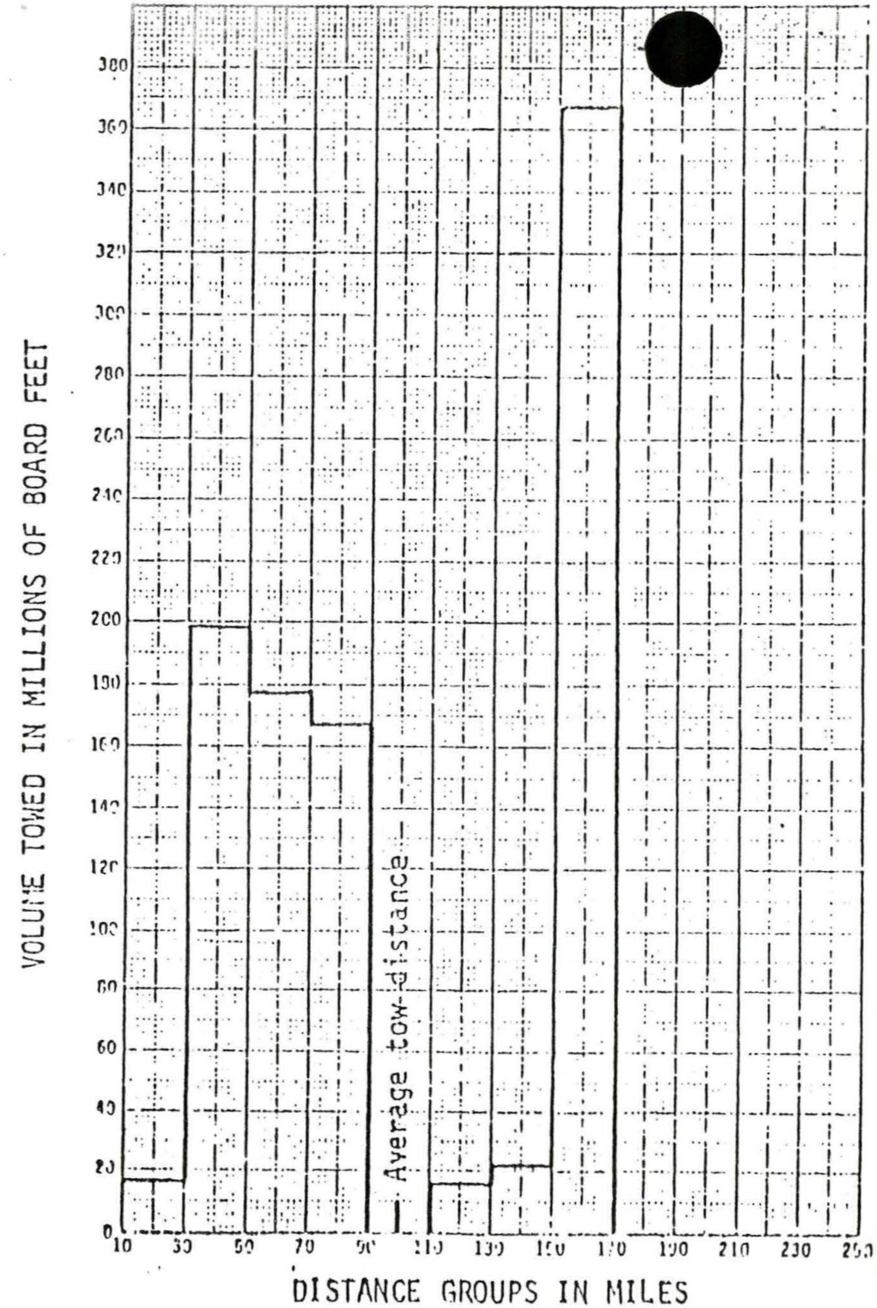

Figure. 2. Ketchikan Pulp Company Log Volume Towed - 1969 Through 1973 - by Twenty Mile Distance Groups. Average Tow - 100.4 Miles

Similarly for a 160-mile tow and a 200-mile tow, the cost range would be $6.50 to $7.70/MBF and approximately $9.60/MBF respectively. Canadian costs are estimated in the $6.50 to $7.00 and $8.00 to $8.50 ranges respectively.

Both towing companies in Alaska indicated that costs are rapidly increasing and that rates are likely to increase by as much as 30% in 1974.

Some volume produced each year is towe to water storage areas and then, as required by the mills, is towed from the storage area to the mill. Therefore an extra tow is needed. Assuming that 25% of yearly production is stored and requires an additional towing cost of $1.40/MBF, the overall cost of additional towing from storage areas to mills would be $0.35/MBF. KPC estimates their costs at $.80/MBF, including maintenance and depreciation of facilities. Perhaps $0.60/MBF would be a reasonable industry average.

Tow insurance is another cost item. Costs on a per MBF basis are difficult to derive, as insurance is currently quoted on a premium per $100 of insured value. In addition, there may be various amounts of deductible before a loss is paid by the insurance and/or coverage other than on logs may be involved, all of which influences rates per MBF.

KPC quotes its cost as 23¢/MBF, but its losses have been so low that it intends to insure itself. ALP pays a rate based on $100 of insured value with a large deductible. Insurers who are active in the Alaska market say that a reasonable rate per 100 dollars of insured valuation is 30¢ to 35¢ on bundled logs with a deductible of $1,000 to $1,500 per tow. Further, they state that the losses would run about 50% of the premium dollars.

Such losses would be incurred only in the event of a major breakup, since the towing companies are responsible for recovering minor losses such as might be incurred when a single boomstick parts or a bundle breaks within a raft.

Based on 1970 cost data, the Forest Service Handbook quotes a tow insurance rate of 18¢ per MBF. Assuming an average log value of $80 per MBF, all of the above data results in an insurance cost in the range of 23¢ - 25¢/MBF. Log loss incurred by the companies will be discussed later.

Dump sites and log storage sites are subject to permit approval by the Corps of Engineers who, in turn, seeks the comments and approval of various state and federal agencies concerned with the marine environment. The approval of permits for these facilities frequently provides for the cleanup of bark and wood debris if found excessive during or after the use of the facility has terminated. To date, no cleanup work has been found necessary but increasing environmental quality standards may require such work in the future. The siting of facilities as a result of this

approval system has frequently been changed from perhaps the most economical location from a logging standpoint to one less economical but more desirable from an environmental standpoint. There could be a cost connected with dump site cleanup and and location change requirements, but its extent is unknown and subject to a great many variables. A reasonable allowance for this is assumed to range from $0.05 to $0.25/MBF.

In summary, rafting costs based on 1973 data from the point logs are received in the water to the point they are received at the mill may range as follows for different towing distances:

	Costs - $/MBF by towing distance		
	100 miles	160 miles	200 miles
Non-towing cost, supplies, etc.	$1.75	$1.75	$1.75
Towing costs	$4.05-4.80		
Additional costs of towing from water storage	$0.60	$0.60	$0.60
Tow Insurance	$0.23	$0.23	$0.23
Water clean-up and dump location changes	$0.05-0.25	$0.05-0.25	$0.05-0.25
Total	$6.68-$7.63	$9.13-$10.53	$12.23-$12.43

It may be noted that the U.S. Forest Service Appraisal Handbook data previously quoted summarizes water transportation costs including part of the above items at an average of $3.94/MBF based on 1971 cost data of $4.43/MBF updated by an inflation factor. Adding $1.75/MBF for non-towing cost items, the total of $6.18/MBF would roughly correspond to the above estimate for 100-mile towing distance which is the approximate industry average.

SECTION IV

LOG BARGING

A. Description of Process

There has been relatively little transportation of logs by barge in southeast Alaska. ALP had the "Western Salvor", a barge it had developed for transporting logs over open ocean waters from Yakutat to Sitka. It was caught in an unexpected storm and went on the rocks outside of Sitka in early December, 1973, with a load of logs for the Wrangell Mill. The barge and logs were a complete loss. The barge was also used, as available, for transporting logs in southeast Alaska waters on the longer tow routes or where a short cut in usual towing distance could be utilized, such as, for example, going outside from Sea Otter Sound, Prince of Wales Island, to Sitka. This route would be about half the distance of the raft towing route.

The "Salvor" was a 3,000-ton steel barge, 302' long by 72' wide with a loaded draft of 16'-17'. It was equipped with a Manitowoc 4,600 gantry crane mounted on rails. The crane had a large hydraulically-operated grapple which would pick up a truck-size bundle of logs from the water. Two rows of logs were placed on the barge so that there was considerable overhang on each side. From 800 to 1,500 MBF could be carried, depending on log size and species. The bundles were off-loaded by grapple in the water. Bundle breakage from off-loading was said to be 20%-30%, depending on operator efficiency. A double wrap and special high-tensile steel strapping and seals were used to minimize breakage from the loading and unloading.

Loading and unloading time was said to be 8 to 12 hours for each function. Travel speed loaded was about 6 to 7 knots and unloaded, about 8 to 9 knots. A typical round trip for the Sea Otter Sound to Sitka tow of about 120 miles (the raft tow distance "inside" would be about twice this distance) would be as follows under good conditions:

Load time	8 hours
Travel loaded	23 hours
Unload time	10-12 hours
Return travel	16 hours
Total	57 to 59 hours or ±2½ days

For various reasons, such as repairs and other delays, only 5 to 6 trips per month were achieved, although theoretically about 9 or 10 would be possible.

Similarly, the Yakutat round trip under good conditions took one week, but the average trips per month were about 3 rather than 4.

The only other barge in use in southeast Alaska is a war surplus landing craft (LSM) equipped with a ramp. The barge is beached and the logs are put on with a front-end loader. Capacity is low, ±200 MBF net scale (250 MBF gross) due to the small size of the barge and the inability of the loader to stack the logs very high. It is a slow process of loading and unloading because loose logs are handled. It can be used only at a smooth beach site and, when loaded, requires a low tide water depth of over 12 feet. It does, however, provide a means to transport small volumes without rafting gear and over waters where raft towing would be hazardous. No direct confirmation of the above data was made.

There is a substantial volume of logs barged in British Columbia. These, almost without exception, are self-dumping barges with capacities ranging from 1 to 4 MMBF. They are also usually self-loading with either a single crane mounted on crawler tracks or railroad tracks or a single or double crane on stationary mounts. Loose logs are loaded with grapples. Two tiers of logs are built on the bottom and logs overhang the sides of the barge.

A single tier of logs on top ties the bottom tiers together. Sometimes a single tier of logs is used but the double tier provides greater stability since the center of gravity is lower. One or more boom boats (bulldozer boats) are carried on the barge. These are used to keep logs within reach of the barge cranes. Proper log loading is the key to a good dump and, as a result, good crane operators are highly valued and highly paid. Barges and tugs are very expensive, so every effort is made to minimize lost time. Crane operators are flown to the loading site and loading takes place day and night until complete. Depending on the barge size, log size, weather, and so forth, loading takes from 10 to 20 hours. On arrival at destination and when the barge is ready for self-dumping (dumps are not made at night), about one half hour is required to achieve the list necessary for the self-dump to occur. Sometimes a dump does not occur or only a partial dump occurs. In that event the logs have to be bailed off with the crane.

Advantages of barging are the ability to travel loaded at a good speed of 6 to 7 knots and, of course, to travel open waters or in bad weather which would negate travel by raft. The system becomes more and more economical as tow distance increases and the speed advantage comes into play. Loading and unloading times and their corresponding operating costs are not variable. Minimum economic tow distance is considered to be about 250 miles in order to achieve a travel time of at least 50% of round trip time.

Since, in general, the logs are loaded and dumped as loose logs, there is a considerable opportunity for log loss from sinkers and a substantial amount of bark and debris is dumped along with the logs.

Because of these two factors, a long tow required for efficiency and loose logs loaded from and dumped into the water, it would seem that this type of log transportation would not be appropriate in Alaska. Assuming that the economics of log movement over the relatively short

towing distances found in southeast Alaska favor rafting (this will be discussed later), it would appear that the only reason to go to barging would be to keep logs completely out of the water in order to avoid impact to the marine environment and to be able to move logs under conditions which would be adverse to towing rafts. Any kind of barging can satisfy the latter reason, but only land-to-land barging can satisfy the former reason.

Land-to-land barging is a system where logs are loaded directly from land storage to a barge and similarly unloaded directly to land again. There has been little or no land-to-land barging in southeast Alaska or British Columbia. It is clear that the barging equipment now in use either would not be suitable or would not be efficient. For instance, in order to achieve an efficient load of logs in barging systems now in use, it is necessary and desirable to load logs so that they overhang the side of the barge. For land-to-land barging this would be generally unacceptable because it would be difficult to tie up the barge to a dock. In order to do so, barges would have to load and unload from both ends. Or the load would have to be self-contained within the dimensions of the barge, which may impose an area limitation on the load rather than a weight limitation. A minor volume of logs has been barged in this manner in Canada.

Kodiak Lumber Mills, Inc., who have a U. S. Forest Service timber sale on Afognak Island near Kodiak, made tentative plans for the use of a land-to-land barging system. The tow was about 100 miles, but much of that distance was over open waters. The barge was planned to be loaded and unloaded with a large log stacker. A 90-foot ramp was needed to extend from land to barge and was designed to handle a tidal range of approximately 12 feet, which was considered a reasonable portion of the total tidal range. There was also apparently the need to time loading with the tide in order to avoid the occurrence of a fully-loaded barge with a low tide. A single tier of log bundles stacked approximately 24 feet high was theoretically designed to make up a load of about 460 MBF. Because log bundles are not as tidy as the designed space and because of practical difficulties in achieving design height with a log stacker, the load was more likely to be about 350 to 375 MBF. The ramp was designed to be moved for reuse. No estimate was given for loading and unloading time, although it should be in the 10 to 12-hour range.

Tidal movements in southeast Alaska range up to 25 feet although the majority of this movement, especially during the logging season, would be more like 15 to 16 feet. Regardless of their extent, obviously some time constraint is imposed and, in addition, nature does not cooperate by providing tides of constant height at all times. Tidal movements impose a locational requirement for sufficient water at low tide to float loaded barges either at docks or at loading ramp points. If a ramp is used, as is discussed above, and the tidal range is 15 to 16 feet, the ramp would need to be about 120 feet long. With a barge having a length of 230 feet, the combination would stretch out in the water some 350 feet

and loading would have to be coordinated to some extent with tides. This somewhat limits the possible locations of barge loading points as compared with rafting dump sites. As a result, if land-to-land barging was required, road construction over that normally required would be necessary to reach these limited locations for loading points.

As noted above, tidal movement will require the installation of expensive facilities for loading and unloading of land-to-land barges. If a crane is used for loading, in order to be efficient it should have the capability to load a bundle of logs or several logs at each time with a grapple. If a wheeled log-stacker is used, it would have this capability but would require the installation of a suitable ramp. In either case, the loading equipment is expensive, as compared to A-frame equipment at a rafting dump site and would have to be permanently associated with either the barge or the loading or unloading point. These facilities may be suitably amortized in a large operation which would be in use for a number of years. For a small operator they would be cost prohibitive and may have a more severe impact on the environment than a bundled log dump. Besides, a dock, ramp or other loading and unloading facilities, a land storage area of a size consistent with the production rate of the logging area or the raw material requirements of the mill would be required.

For several reasons, land storage areas are desirable, even when logs are ultimately moved to the mill by raft. A better job of sorting logs for end use can be done on land. Land storage is preferable to water storage because the possibilities of teredo damage to logs stored in water. Unfortunately, because of the terrain in southeast Alaska, there is a very limited area of land which is situated at the right location and which can be physically and economically developed for this purpose. A 2 to 4-foot-deep layer of coarse quarry rock is necessary to support the weight of trucks, log handling machines and logs. About one acre of level area is required to store about 1 MMBF. This would be in addition to the normal 1 or 2 acres required at dump areas.

Both KPC ALP have developed or are developing level storage areas at their major log production centers. KPC's Thorne Bay is the largest and can store about 25 MMBF of sawlogs. However, large operations are relatively few in number while there are a large number of small operations. Even if there were areas available to each small operator to develop storage areas, the cost would be prohibitive and there could be undesirable environmental impacts upon the land of these areas.

Both pulp mills and several of these sawmills are located in an area and in a way which is oriented toward water delivery of logs and which have short term water storage areas nearby. In the event that land-to-land barging was required, there would be great difficulty in providing the short-term land storage areas required to ensure a continuous log supply to the mills. Suitable land of sufficient area is not available. The development of such land, if physically possible, by excavation and/or fill,

besides being very expensive, would create its own environmental impact.

It could be said that sufficient logs could be stored on barges for use as needed. Each pulp mill uses about 500 MBF per day. Assuming that a barge of the approximate dimensions of 50' x 230' (Kodiak Lumber Mills, Inc., design) would have a capacity of about 350 MBF of pulp logs contained within the dimensions (no overhang) of the barge, ± 1.4 barges per day would be necessary to satisfy daily log requirements for each mill. Even barge movement is limited in certain waters due to adverse weather. Therefore, the minimum requirement for log supplies immediately available to the mill, in order to ensure continuous production, may be on the order of a ten-day supply or 14 to 15 barges immediately on hand. Sawmill requirements vary from 1/5 to 1/2 of these requirements.

Or, looking at this another way, assuming that the annual cut from southeast Alaska is 600 MMBF and that an average barge capacity for pulp and sawlog loads (contained within barge dimensions) is 375 MBF, some 1,600 barge movements would be required each year. Further assuming that on the basis of an average 300-day work year (pulp mills more or less continuous and sawmills on a 5-day work week), some 2,000 MBF of logs would be consumed per day, or, at the above volume of 375 MBF per barge, some 5.33 bargeloads per day would be used. At the tend-day availability rate, some 53 to 54 barges would be required at or near the mills. At a five-day availability rate, some 26 to 27 barges would be required.

Then there would be the requirement for barges in transit and at the loading point. Assuming a loading time of 12 hours, an average loaded and unloaded time of 28 hours, an average tow distance of 100 miles, and a delay time for weather, repairs and so forth of 8 hours, some 48 hours or two days would be required per bargeload, assuming around-the-clock operations. It would be more practical to assume that all operations would not be around the clock. Also, because logs of one sort would have to be placed on one barge, there would no doubt be some delay time for some barges in order that sufficient logs of the right sort be on hand. Considering the above, it would seem reasonable that a three-day travel time and load time from mill back to mill would be required. At the consumption rate of 5.33 barges per day, an additional number of barges, in the magnitude of 3 times that number, or 16 more barges would be required for an approximate total of 42 to 70 barges.

Barges can be of different capacities than above estimates. A larger barge would tend to be more efficient, in that roughly the same level of labor would be required for either large or small barges. The smaller barge would tend to provide more flexibility in operations such as in scheduling and in ability to service smaller production units especially since it is necessary to sort logs by end use.

In the above estimates, the load has been assumed to be within the confines of barge width because of docking problems when logs overhang the width. In using the ferry-type ramp and loading with a log stacker from one end of the barge, it would be possible to load a barge with logs overhanging the side and thus transport a larger load. Barges loaded in this manner would have to be especially strengthened for the impact of the loader and its load of logs. Loading rate may be affected adversely and dock facilities may or may not be affected, depending on local terrain. This loading possibility was considered in the Kodiak Lumber Mills barge design and was discarded as being technically possible but not practical. If barging became standard, no doubt barge design and loading/unloading methods would undergo great improvement. At this point in time, the Kodiak Lumber Mills preliminary design is the only one found to consider the land-to-land barging concept.

Regardless of the barge size or loading system employed, it is clear that a considerable number of barges would be required to completely service the forest industry in southeast Alaska.

B. Costs

There is data available for the movement of logs in Alaska by a barge system where logs are loaded from water and unloaded into water. The "Western Salvor", operated by ALP, moved logs at the same cost rate/MBF as towed rafts for certain loading and unloading points. This was said to be at a cost of approximately twice that per MBF per mile of the rafting rate. However, the locations on which the "Salvor" was used allowed it to travel about half the distance of the towed rafts in order to reach the same destination. In other words, a direct tow route in unprotected waters not available to raft tows. Most log-producing areas do not provide this economy in tow distance. Another estimate of cost provided was 6¢/MBF/mile towed plus $1.00/MBF for loading and unloading These rates were based on gross scale. Rates based on net scale are customary for raft tows.

There is also some data available about costs of the self-dumping barge system in use in Canada although sources tend to be reluctant to be specific. It should be noted that loose logs are moved under this system and the cost of sorting, bundling (if desired), storage, and movement to the mills would have to be added for comparison with both the rafting and barge log movements used in Alaska. Furthermore, the dumping of loose logs intensifies the adverse environmental impacts that prompted this study and which are trying to be minimized in Alaska.

Canadian estimates indicate a barge capable of carrying ±1½ MMBF on a 250-mile tow would take approximately four days on the following scheule:

Unloaded run	24 hours
Loaded run	36 hours
Loading	24 hours
Dump and delay	12 hours
Total	96 hours or 4 days

The approximate cost for the above is said to be ± $9.00/MBF, BC log scale. Breaking jackpots, sorting and flat rafting run about $3.65/MBF for a total of ± $12.65/MBF. Canadian costs tend to be lower than Alaskan costs although BC log scale tends to be slightly higher than the Scribner scale used in Alaska and Puget Sound. Therefore, for comparison purposes with Alaska, the above cost may be increased by an estimated 10% to $14.30/MBF, Scribner, which is roughly equivalent to an Alaska raft tow cost for the same distance. However, costs related to adverse environmental impacts should also be added. These, although not estimated, would be substantial in magnitude in the case of the Canada self-dumping barge system as compared to log rafting in Alaska.

Barging is a capital-intensive system. Current barge rates are based on capital costs when the barges and tugs were constructed. Current capital costs of comparable equipment are considerably higher and are on the increase. Therefore, estimates of capital costs are notably imprecise and only indicate the probable magnitude. During the last year, construction costs have increased approximately 30%.

Under the present system of barging, the tugboat is essentially married to the barge while the system is operating for the loading and unloading time is too short to allow the tug to perform other tasks. In Alaska, under a land-to-land barging system, a ratio of one tug to two or more barges may be achieved. It may also be possible to tow two barges with one tug to achieve some economy in operating cost, although this might be at the expense of additional barge requirements. Tug operating costs are substantial, so a system which requires the least amount of standby or non-operating time will spread this cost over a greater volume of logs.

Replacement costs per operator estimates of several barge systems now used are shown below:

ALASKA

The "Western Salvor" (went on the rocks near Sitka and destroyed, December, 1973)

Length	302'
Breadth	72'
Depth	16'-17' (load to 2'-3' freeboard)
Tonnage	3200 tons
Crane	4600 Manitowoc with hydraulic grapple

Capacity . . . . 800 to 1,500 MBF depending on log size and species or camprun, ± 1 MMBF.

Tug . . . . 1,000 h.p. (was not lost)

Replacement cost (per U.S. Salvage Company)

Barge . . . . . ± $2.0 MM
Crane . . . . . ± $0.5 MM
Tug . . . . . . + $1.0 MM

Distribution of income:

Barge . . . . . 40% for depreciation
Tug . . . . . . 60% for operating costs and depreciation including log loading

Land-to-Land, ramp loading, ± 0.37 MMBF capacity (Kodiak Lumber Mills concept)

Length . . . . 230'
Breadth . . . . 55'
Capacity . . . . 0.35 to 0.4 MMBF
Tug . . . . 750 to 1,000 h.p.

Replacement costs:

Barge . . . . . $0.75 to $1.0 MM
Ramp . . . . . $0.1 MM
Tug . . . . . . $0.5 to $0.75 MM (Estimate by INFO)

CANADA

Costs are those quoted by Canadian towing companies. Inconsistencies may be apparent.

Self-loading and self-dumping, ± 1 MMBF capacity

Length . . . . 285'
Breadth . . . . 61'
Depth . . . . 16'
Capacity . . . . 0.75 to 1.2 MMBF
Tug . . . . 1,500 to 1,800 h.p.

Replacement costs:

Barge . . . . . ± $1.0 MM
Crane . . . . . ± $0.5 MM
Tug . . . . . . ± $1.0 MM

Operating cost . . . . $3,600/day (negotiable; probably more like $3,000 to $3,200/day long-term basis)

Self-loading and self-dumping, ± 1½ MMBF capacity

Length	360'
Breadth	66'
Depth	16'
Capacity	1.25 to 1.75 MMBF
Tug	2,500 h.p.

Replacement costs:

Barge and crane	± $2.25 MM to $3.5 MM
Tug	± $2.0 MM

Operating costs . . . . . . ± $3,600/day

Insurance for barging equipment generally includes $25,000 deductible and rates of 3% of the insured value for barges and for tugs, 3% of insured value for new equipment and 4% on old equipment.

Most towing authorities who have been consulted recommend the smaller barge or the ± 1 MMBF capacity barges for southeast Alaska conditions.

ALP has estimated the cost of transportation for logs by barge at the rate of 8¢/MBF/mile plus $1.00/MBF for loading. Using the ratio of the rate expressed in Baggen's formula for rafting tows in excess of 100 miles to the rate for log barges as set forth in the Forest Service Appraisal Handbook 2409.22R10, amended October, 1973, which is based on the 1970 cost data, and the 1973 rate as expressed herein, the above rate of 8¢/MBF/mile is confirmed. The figures used are:

$$\frac{\text{1973 barge rate}}{\text{1973 tow rate - \$0.048}} = \frac{\text{1970 barge rate \$0.054}}{\text{1970 tow rate \$0.0323}}$$

$$\text{1973 barge rate} = \text{\$0.08/MBF}$$

Loading and unloading facility capital and operating costs are very difficult to estimate since conditions would vary so much from location to location, particularly for loading points.

In a sense, the receiving points at the mills would be relatively simple in that once the installation was completed, it will theoretically serve its purpose for a number of years while the loading points will have a limited life. From a practical standpoint, it is not simple since the mills are oriented for water delivery of single logs or a bundle of logs. Both pulp mills have installations, costing in excess of $5,000,000, which removes a bundle of logs from the water for breaking on a dry deck. Neither mill has sufficient adjacent land which could be developed for land storage. It is conceivable that, in some manner, each could develop facilities for removing logs from barges for direct or almost direct use in the mills. Conditions at the sawmills vary and are beyond the scope of this investigation. In general, they are probably oriented for the removal of individual logs from the water to the mill. The availability of dry land storage sites available to them is unknown.

It can be safely said that capital investment would be large for facilities for barge-to-land receipt of logs. No one interviewed was able to give an estimate of cost. Based on the estimated cost of $5,000,000 for log receiving facilities at the pulp mills, barge receiving installations may run between $10 to $20 million or more plus real estate costs.

Loading docks will also vary greatly in cost, according to physical conditions at each site. The number of sites available, because of necessary terrain for land storage, beach and water conditions, would be greatly restricted over the number of sites available for the placing of bundled logs in marine waters. Therefore, besides the cost of dock facilities, the cost of additional road development required to reach those facilities from timber locations would also be involved.

Together with necessary land storage development, a rocked, level area of sufficient size to store a volume of logs consistent with the size of operations at the barging points, the magnitude of such construction at a barge loading point may be as much as 2 to 8 times the present dump site capital and operating costs. This would tend to make many smaller areas of timber supply uneconomical to operate and cause adverse effects on economic timber supply.

Insurance costs are said to be the same as for rafting logs. Another cost associated with barging is the cleaning of bark and debris from the barge. Assuming that this could be done on every other use at a cost of $200 and each use involved 400 MBF, the total volume for each cleaning would be 800 MBF and the cost per MBF would be $0.25.

Overall the capital cost for the land facilities for barging of logs is beyond estimate. The range may be from 5 to 10 or more times the cost of present rafting facilities. The operating cost per MBF may also be in that range.

In summary, the costs associated with land-to-land barging in southeast Alaska, for an average tow distance of 100 to 110 miles as compared to rafting are set forth in estimated order of magnitude.

ITEM	ORDER OF MAGNITUDE
Extra access road required to reach suitable loading sites	1 to 5 miles at $40,000 to $50,000/mile
Land storage requirement at loading point and unloading dock facilities	2 to 8 times rafting requirement
Load, unload and tow operating costs	2 to 3 times rafting rate
Unloading facilities and storage area requirements at mill	5 to 10 times present cost
Tow insurance on logs	No change
Log losses	Small savings of ± 20¢/MBF
Cleanup of barge	About same as cleanup of rafting dump or storage areas.

Without calculation, because of variability of conditions at loading and unloading points, but in consideration of the above, land-to-land barging cost may be estimated at 3 to 6 times the cost of moving bundled logs by raft and water storage of rafted bundled logs. Capital requirements may be 50 to 100 times that required for log rafting.

SECTION V

OTHER CONSIDERATIONS

A. Log Losses

Many people have pointed to driftwood on beaches and said that huge losses are sustained from the water transport of logs. Numerous articles have appeared in trade magazines and newspapers, particularly in British Columbia. A recent study on log losses has been made by the Council of Forest Industries in British Columbia (Reference No. 29). Although the study has not been published, its recommendations have. Much of the study concerns itself with debris in the Fraser River but water movement of logs in marine waters was also studied and recommendations were made for improved log handling. There have been and still are significant log losses in Canada but the situation in Canada and in Alaska is greatly different.

Log losses come from sinkers or low floaters or from raft breakups. The Canadian practice of using self-dumping barges and flat rafting of loose logs can result in log losses. Towing and storage of flat rafts can result in log losses. The breakup of a raft or a barge can also result in log losses.

The current Alaskan practice is to bundle logs with steel strapping before they are placed in the water. Sinkers, being in the minority, no longer sink or become low floaters or deadheads as they are maintained in a floating bundle. The bundles are combined in a raft and towed to the mills or to storage areas. Pulp logs are lifted from the water as a bundle and are broken on a dry deck. At one time, bundles were broken in the water and sinkers or low floaters were subject to loss. Sawlog bundles are generally broken in the water in front of the mills. However, these logs are big and methods to eliminate loss are simple and profitable to use.

Occasionally the strapping on a bundle in transit or in storage will break or a boomstick will break, letting a few bundles go free. Storage areas are patrolled for damage of this sort and rafts are kept in repair. Occasionally, a tow is caught in a weather-vulnerable position, and loss results.

However, an initial loss does not mean an unsalvaged loss, for it is the towboater's responsibility to salvage losses for logs under tow. Most mills provide a market for logs lost from storage. A few small boat owners provide a log salvage service for company-owned logs.

KPC estimates its log losses at about 0.1% per year, as follows:

Spills during towing	± 100 MBF (333 logs @ 300 BF/log)
From storage areas	± 100 - 200 MBF (333 to 666 logs @ 300 BF/log)

It estimates the recovery of these losses at 80% - 90%. ALP estimates similar figures as do towing operators.

The Forest Service allows a 1 percent loss by log count in the transportation process. A count of the logs is made before they are placed in the water and as they are scaled at the mill. If the dump count is 1 percent greater than the scale count, the raft scaled volume is adjusted to reflect the dump count. This assumes an accurate dump count was made. Forest Service data on 1,054 rafts produced to KPC indicates a tendency to under-count the number of logs being dumped. This may be due to difficulty in obtaining an accurate count on pulp log loads which may contain 40 to 60 logs having small diameters and different lengths. There should be no excuse for over- or under-counting sawlog loads.

In any event, it seems clear that log losses from towing and storing bundled logs under current practices in southeast Alaska are minor and that the majority of these are recovered. There is no reason why continued vigilance and improvement in equipment and methods cannot reduce this even more. As mentioned before, KPC considers its loss so minor that it will no longer insure itself from outside sources.

On a cost per MBF basis assuming a camprun log value of $80.00/ MBF, the loss rate of 0.1% as estimated by the industry would result in a cost of $0.08/MBF, or at the rate of 1% as allowed by the U.S. Forest Service would result in a cost of $0.80/MBF. Neither cost considers recovery estimated at 80% - 90% less cost of recovery. Minor losses occuring during towing are usually recovered by and at the cost of the towing company. For other salvage, KPC is paying $55.00/MBF at Ward Cove. Assuming that half of the volume lost is recovered at no additional cost, half at the above salvage rate and the balance of 20% is not recovered, the actual cost is about half that estimated without any recovery. This cost is estimated to be ± 20¢/MBF.

Under normal circumstances, there should be no loss of logs from land-to-land barging. However, the loss of a Canadian log barge several years ago and the recent loss of the "Western Salvor" indicates that log losses can occur even with barging.

B. Volume Losses

Volume or log grade losses can occur in logs in storage from insect attack such as the ambrosia beetle or marine organism attack such as teredos.

The ambrosia beetle or pinhole borer makes small pinholes in logs, thus causing more degrade than volume loss. A common method of prevention is spray misting logs with water. The natural rains in Alaska provide a good deterrent, and it is not believed that ambrosia beetles are a real problem. Losses, if any, would tend to be more severe in barged logs, since they are protected only by rainwater, while the portion of logs in water storage which is not under water is not protected any more than logs in land storage. Differences in degree of damage between the two transportation systems is not believed to be significant.

On the other hand, damage from teredos can be significant if proper procedures are not followed. The severity of damage from location to location varies, but can be minimized by (1) proper rotation of use of water-stored logs to limit the storage time period to a maximum of nine months, or preferably three to six months, depending on water conditions; and (2) storage in areas where the logs can go dry at low tide and where the flow of fresh water is abundant, as apparently teredos are not deterred by brackish water.

Teredos do damage by boring into the portion of logs which are under water. If the above actions are not taken, a sawlog particularly can be damaged beyond use. Pulp logs can be utilized even though logs are badly damaged, but fiber yield is diminished. KPC utilizes their dry land storage at Thorne Bay for sawlogs in order to maximize use of water storage for pulp logs.

The timber industry is aware of the possibility of loss and plans its actions accordingly. Losses therefore are not considered significant or are considered controllable under present conditions. Land-to-land barging should present no problems in this regard.

There is a subtle volume loss wherein land-to-land barging will present a real problem. As mentioned previously, under current conditions, certain cull sawlogs are harvested and transported for use in the pulp mills. This use provides some cleanup of cull logs in the logging areas and effectively extends the timber supply. These logs, having sawlog defects, may be fragile and may not stand the handling necessary in the barge loading and unloading processes. But, more seriously, the increased cost of transportation by barge may make this cull log use uneconomic and thus adversely affect timber supply and constitute an unnecessary resource waste.

C. Stealing

There has been comment, especially in Canada, that those engaged in log salvage may liberate logs that are not in salvage status. The markets for salvage logs in Alaska are limited, and those engaged in salvaging lost logs generally work closely with the mills.

The State of Alaska has a log salvage law wherein one interested in salvaging logs in a certain area can make application to the State. Unbranded and branded logs over two years old (logs are date-branded) are considered State property. Branded logs less than two years old still belong to the brand owner. The State and KPC made a survey of a beach area where there were many drift logs and translated the results to a mile of similar, but of course, not typical beach. Total net volume estimated for logs usable by KPC was estimated at 103 MBF. The percentage of volume by species was: Spruce - 45%, hemlock - 20%, red cedar - 16%, Douglas fir - 10% (!), black cottonwood - 6%, pine - 2%, and yellow cedar - 1%. Many logs were found with iron of some sort in them which indicates that their original use was for something other than logs for the timber industry. KPC provides a market for usable salvage logs at $55/MBF.

It is assumed that assignment of salvage areas by the State results in a responsible salvage operation and that stealing, if there was any, would tend to be eliminated.

D. Damage to the Environment

Various comments by environment scientists and public environmentalists have probably prompted the Forest Service to contract for this study.

Leopold (1972) states, *"The use of barges is recommended, because this method of transportation would solve many of the problems encountered with log rafting, as long as barge pickups are made frequently enough to eliminate the need for large stockpiles of logs on land. Barges can be used in rough weather, can be towed faster, and reduce the loss of logs which occasionally occurs with rafts. Salvage costs, boating hazards and debris on the beaches would be minimized. Furthermore, barging would eliminate the accumulation of bark and debris which occurs at dump sites (Ellis, 1970). Finally, barging would eliminate the need for log storage in the intertidal zones, which should be protected because they produce eelgrass and invertebrate life valuable as waterfowl food (Cottam, 1939)."* (Reference No. 46)

Others have said, *"We would have liked to have an opportunity to comment on a combination upland storage and barging plan for this logging area since we believe this system of log transportation has real potential for reducing adverse effects on fish and wildlife resources."* Or, *". . it would be desirable, from a biological standpoint, to keep logs out of the water during the entire transport process."* (Reference No. 71) Or, *"The common logging practices of log dumping, rafting, and storage in marine waters in Southeast Alaska do cause environmental damage of varying degrees, depending primarily upon the location. The few studies completed evaluating this aspect that we are aware of indicate a possible substantial loss of environmental values. To put a price tag on this loss is extremely difficult due to the highly complex interactions of an estuarine ecosystem."* (Reference A-8)

Interestingly, Schaumburg (1973) states in regard to a recent study in Oregon, *"My analyses clearly show that the present water handling methods create a lesser impact on the total environment than would be experienced by the dry handling approach."* (Reference No. A-27)

Finally, Pease (1973) states, *"The present system of log barging is at least as harmful to the marine environment as log raft towing, because logs are loaded onto the barge from the water near the sale area and unloaded into the water near the mill site. Thus, the logs are dumped into the water twice, and twice as much bark and wood debris enters the marine environment. This effect could be minimized by loading and unloading barges from land, but the feasibility and environmental impact of building dock facilities and the associate dry-land storage facilities in Southeast Alaska are unknown. . . . The feasibility and environmental impact of dry-land storage and barge transportation of logs should be studied."* (Reference No. 52)

Obviously, insofar as the impact on the marine environment is concerned, the elimination of all activity in the waters of southeast Alaska would eliminate the problem -- and there are some who would probably advocate this approach. However, since the harvest of the timber resources is presumed to be a desirable activity for southeast Alaska and physical conditions dictate that water transportation of logs to mills be used, it is pertinent to objectively view the results of studies to date and to attempt to evaluate the relative costs to society of adverse impacts and the use of alternative transportation methods.

Most environmental or marine scientists indicate that only a few studies have been made so far and that definitive information is still lacking. Several studies have been planned to increase this knowledge. Ellis of the Auke Bay Fisheries Laboratory made a preliminary study in 1971 on the effects of log rafting and dumping on marine biology. (Reference No. 32) A more comprehensive three-year study is planned to begin in 1974. It is understood that the Canadian Department of the Environment, Fisheries Operations, intends to make a similar study.

As a result of the studies which have been made, improved log handling practices have been suggested and, it seems, implemented to a large degree.

The studies have been concerned with the effects of log dumping and rafting on water quality and on benthic (bottom-associated) organisms and the quantity and effect of leachates from each species on marine organisms. The various studies seem to be comparatively consistent in their findings, and an attempt will be made to summarize them from a layman's standpoint.

Bark deposits in varying degrees of thickness are found on the bottom at dump sites depending on tidal flushing and water currents. The major effects include an increased biological oxygen demand (BOD) and a lower percentage of dissolved oxygen (DO) and a smothering of benthic (bottom)

organisms. These adverse effects are apparently quite local, within 50 - 100 feet of dump sites, and tend to disappear over a period of time after use of a site is discontinued. Some leachates (chemicals leached from wood and bark) are toxic, but are seldom in concentrations sufficient to kill fish. They may be more injurious to bottom shellfish. They also create a significant BOD and tend to diminish the DO. The relative demand rates tend to be minimized in cold Alaskan waters.

In reference to leachate toxicity to marine life, laboratory studies which were available to this report (i.e., Pease, Buchanan, Schaumburg) indicate that toxicity is much greater in fresh water than in salt water and that different tree species are most toxic in each. In salt water, Pease indicates that in regards to pink salmon fry, yellow cedar leachates are the most toxic. Buchanan indicates that in regards to shrimp and Dungeness crab larvae, spruce leachate is the most toxic and hemlock leachate has very little toxicity. The cedars were not tested in Buchanan's study.

However, in testing of marine waters at dump and storage sites in southeast Alaska, Pease found that toxicity levels at most areas were too low to measure. Two sites did provide measurable levels - Thorne Bay and Herring Cove - although the leachates were present in levels generally below those found toxic in the above studies. And, as Pease states, *"it is unlikely that fish would stay in an area of high leachate concentration without swimming away."* (Reference No. 52)

Basically, at this time it can be said that the adverse environmental effects from log dumps are not serious and are mostly due to the accumulation of bark, and that such effects are quite local to the dump area. These effects may be minimized by bundling the logs and very carefully lowering them into the water. Strapping and other debris should be kept out of the water and perhaps periodic or final use cleanings or bark removal should be made.

The main effect from rafts in storage seems to be the shading effect which tends to eliminate marine vegetation and the crushing effect on benthic organisms when bundles ground at low tide. These effects appear to be local.

Both Schaumburg (Reference No. 59) and Pease (Reference No. 52) indicate that adverse effects on the marine environment are localized, do not exert a major problem, and can be minimized by good log handling practices. Marine scientists interviewed confirm these conclusions butstate that they would prefer that no logs be placed in the water. Some state that since the damage is done in regards to present water storage sites, they may as well be continued in use.

The EPA study on Silver Bay states that water quality in 1956-57 was very high. *"Previously, wastes from logging and sawmill operations had been introduced into the Bay, but grossly perceptible after-effects on water quality were not observed . . . demonstrating the high quality of these waters."* (Reference No. 33)

Dickason, Director, Alaska Operations Office, EPA, states:

"We have experienced a very high degree of cooperation from the logging industry in most areas associated with navigable water use . . . I might point out that members of our staff have made a few brief observations of the effects of log dumps and log storage areas in Southeastern Alaska. Our all-too-few observations are by no means conclusive, but I would like to pass on to you the results of them.

"First, log storage in intertidal reaches does not appear to always result in significant damage to intertidal plants and animals, nor does it necessarily result in a perceptible change in water quality. Also, log storage in deep water sites does not always result in significant or perceptible environmental degradation, because such variables as tidal and other currents, banding of logs into bundles, location of storage sites, and so forth, always temper the effects on the environment. Dumping or skidding of logs to get them into the water for storage and transport does not always result in significant environmental damage either. Rather, if accumulations of lost wood solids in bottom deposits associated with log dumps are found, they appear to be highly localized. There are cases when past intensive logging activities over a period of several years have resulted in substantial and significant accrual of lost wood solids several feet deep. Such cases appear to be few in number and usually occur in highly protected embayments."
(Letter to author - 1974)

As mentioned heretofore, applications to the Corps of Engineers for new dump or water storage areas are passed to various government agencies for comment. Comments concern both the siting of the prepared facility and conditions of use. Siting considerations may include avoiding the location of eelgrass beds (waterfowl food) and bald eagle nests (eagles are disturbed by nearby human activities) in trees in nearby shore areas. Conditions of use may include a sampling program to determine the extent of deposition of bark and debris, if any, andthe removal of significant accumulations upon termination of the use of the facility. Pleasure boaters object to the granting of raft storage sites, but on the other hand, request that cleats be placed on standing booms so that they may tie up to them.

Barge operations would also cause adverse environmental impacts. Marine environments would be impacted to the extent that construction of loading docks would result in the covering of more beach area than the facilities required for the placing of bundled logs in the water. Although it is conceivable that there may be fewer shipping locations in barging, there would be much less flexibility in site locations and each location may affect a larger area. It is conceivable that the overall impact on such things as eelgrass beds and bald eagle nexts would be greater.

There could be no argument thatthe impact on the upland environment would be much greater. Much more road than usual would have to be constructed in order to connect several usual dump sites to a barging

site because of less flexibility in locating barging sites. More land area for log storage would have to be developed. The impact on the upland environment is not known but it is conceivable that the adverse effects thereon may be equal to or exceed those found on marine environments from log rafting operations.

It may be well to put in perspective the extent of use of marine waters in southeast Alaska by rafting area. A Forest Service estimate of raft storage areas compared to overall estuary area in southeast Alaska indicates the following:

1.	Area of coves and bays	=	334,540 acres
2.	Area of all inside waters	=	7,103,000 acres
3.	Area of rafts at present [650 rafts @ 0.9 acres/raft x 2 (allowance for space between rafts)]		1,200 acres

Another source (Pease, 1973) estimates that 650 acres was used for the water storage and handling of the 560 MMBF harvested in 1970. Assuming that the average raft is approximately 70' x 550' or 0.88 acres and contains 400 MBF, and that this area must be multiplied by 1.5 to allow for inefficient use of area by rafts and for dump sites, then 1 MMBF would cover 3.3 acres. Further assuming that 300 MMBF may be the maximum volume in the water at any one time, some 990 acres would be covered. Log Storage and Rafting in Public Waters, a 1971 report by the Pacific Northwest Pollution Control Council, estimates that sixty-nine sale area dumpsites and storage areas used 430 acres of water; that thirty-eight raft-collecting and storage areas used 469 acres; and that mill storage, raft breakdown and sorting facilities (now minimized with pulp bundle breaking on dry dock and log sorting in the woods) used 84 acres. The total of these is 983 acres.

Therefore, the magnitude of acres used seems to range between 650 and 1,200 acres. Assuming that an average of the range, or 925 acres, is most nearly correct, this would be 0.28% of the cove and bay area or 0.013% of all inside waters. It is true that this is a shifting acreage and that the sum total of acres of water affected by log dumps or storage areas at one time or another is much greater. However, as noted in the EPA study in Silver Bay, after use of marine waters for dumping or rafting is discontinued, in time the water again becomes pure.

Perhaps one way to put a value on water quality environment observed to be adversely affected by log rafting would be to multiply the yearly value of the fishing industry in southeast Alaska by the percentage (previously calculated) of cove and bay areas utilized for log dump and log storage. This results in the following calculation for 1971 data per "Alaska Statistical Review" for southeast Alaska.

Item	Catch - 1/ Millions of Pounds	Value - 2/ $/Thousand Pounds	Total Value - Millions of $
Salmon	65.1	$767	$50.7
Shellfish	3.5	800	2.8
Other fish	16.7	300	5.0
Sub-total			$58.5
Sports fishing, estimated value			6.5
Total			$65.0

1/ Pg. 69, Alaska Statistical Review
2/ Pg. 82, ibid. Values for shellfish and other fish were estimated. Value for salmon from table.

Sixty-five million dollars multiplied by 0.28% (page 34, this report) equals $182,000. Assuming that the value above determined was in fact the value of fisheries adversely affected by log rafting activities and that barging would not adversely affect fisheries (these are very favorable assumptions for the barging concept but are not necessarily true), the cost based on an annual log production of 600 MMBF would be $0.30/MBF.

E. Damage from Loose Logs or Towing Rafts

Loose, floating logs can be a hazard to boaters. The Coast Guard states that there have been reports of floating logs in the vicinity of the pulp mill at Ketchikan. Although no incidents were reported, no doubt minor collisions have occurred. It is not known if these reports were before or after the installation of the dry deck.

In regard to damage to aids to navigation from towing of log rafts, the Coast Guard reports that there were three collisions in 1972. There was also one by a pulp chip barge. The Coast Guard states that there have been very few boating accidents or damage to fishing boats or gear reported to them. Two collisions with floating logs were reported but they did not meet the criteria of marine casualties which in the minimum context is damage of $1,500 or more or which affects the seaworthiness of a vessel. There are no doubt minor collisions which go unreported. The incidence of damage overall is quite low, and they believe there would be little difference between rafting or barging.

There is adverse comment from some concerning the "mass" of drift logs on beaches. It is true that there are lots of drift logs on the sandy, exposed beaches. Many of these logs are not from logging activities and many logs may have been on the beaches for a long time. To some people, drift logs are an eyesore or are aesthetically displeasing. To others, a beach without drift logs may be uninteresting.

SECTION VI

SUMMARY OF ADVANTAGES AND DISADVANTAGES

At the outset it may be well to summarize the advantages, disadvantages and comparative effects on the environment between log rafting and log barging (land-to-land).

A. Physical Factors

1. Flexibility in selection of dump/loading sites.

   Rafting - quite flexible from standpoint of both physical and environmental conditions.

   Barging - much less flexibility from both marine and upland standpoints. Possible barging sites are very limited.

   Comment - it would difficult to service the low volume producing operations by barge.

2. Dump/loading facilities, land and marine.

   Rafting - minimal from both standpoints in low volume operations. May be more elaborate where land storage sites are located.

   Barging - standard of facilities can't vary much. Requires extensive land storage and sorting area.

   Comment - evidence of use upon termination of operations is directly affected by size of marine and land disruptions.

3. Log sorting flexibility.

   Rafting - sorting is simple but reasonably effective. Cost is low.

   Barging - sorting at land storage area can be better accomplished. Cost is relatively high.

   Comment - sorting is now supplemented on pulp dry decks where sawlogs are removed or improved by bucking and sent to sawmill.

4. Flexibility of tow in regards to log destination.

Rafting - very flexible. Both pulp and sawlog rafts can be towed together and separated at will. Makeup of raft by log sort is simple. Partial rafts can be held in storage.

Barging - inflexible. Sufficient logs of one sort must be accumulated in land storage for barge capacity. Not practical to mix pulp and sawlogs as destination is different.

Comment - it may be possible to accumulate bargeloads of one log sort from several loading points with diminished efficiency and depending on the loading system used.

5. Tow travel rate.

Rafting - slow, about 1½ - 2 knots.

Barging - about 6 to 8 knots.

Comment - although slower, the volume in a raft tow can be 4 - 5 times that in a barge tow assumed appropriate for Alaska. Speed of tow is of interest only as cost factor in determining cost/MBF of barging or towing.

6. Return travel rate.

Rafting - tug is unencumbered.

Barging - a few knots below above.

Comment - there is less flexibility in barging. In rafting on the return trip, the tug may perform other duties.

7. Tow capacity.

Rafting - depends on size of log and water or seasonal conditions. Can be relatively flexible.

Small tug - 4 rafts in the winter to 6 rafts in the summer, or 2 to 3 MMBF.

Large tug - perhaps up to 9 rafts or ± 4 MMBF.

Barging - capacity can range up to 4 - 5 MMBF, but ± 0.5 to 1 MMBF capacity seems most suitable for Alaska conditions. Is not flexible.

Comment - capacity is mainly pertinent in the calculation of costs although flexibility is also important.

8. Suitability of use in severe weather conditions.

Rafting - is said to have about a six-month season, or 50% availability in southeast Alaska for long tows. Some logging areas have a longer operating season. Tows from storage areas are almost year round.

Barging - is said to have about a nine-month season or 75% availability.

Comment - this comparison leads one to the conclusion that some barge facilities - not necessarily land-to-land - may be a desirable thing. However judicious storage and scheduling has provided mills with a reliable log supply.

9. Receiving facilities.

Rafting - industry mills are oriented and designed for water delivery of logs. Pulp mills break bundles on dry decks - sawmills in the water.

Barging - facilities would be expensive and difficult to construct. Little or no land area available at mills for log receiving and storage.

Comment - the overall environmental impact may be greater in the case of land receiving and storage.

10. Storage facilities.

Rafting - some land storage where volume of production and terrain permit. Otherwise water storage, usually in areas that have been in long-term use.

Barging - would require extensive development of land storage areas as well as a number of barges for short-term storage in front of mills.

Comment - it would seem that this is one of the least desirable aspects of barging. The high capital cost of barges and associated equipment is self-evident. The high cost of development, environmental impact from the clearing of land, lack of area at pulp mills, and unknown real estate costs may not be quite so evident but no less real. Log volume storage requirements are independent of the transportation system.

11. Log losses.

Rafting - losses from spills or attrition are very low and degree of salvage is good. Nevertheless a few logs are lost.

Barging - there should be no loss, except for casualties like the "Western Salvor".

Comment - handling methods for rafted logs can no doubt be improved even more.

12. Volume losses.

Rafting - there is some volume loss due to teredos, but it is controllable by careful watch on length of time logs are in the water and storage conditions. Some land storage is available for higher value sawlogs.

Barging - if ambrosia beetles were a problem, there would be more loss than from rafting, but losses in Alaska should be minimal. There could be some volume loss from log breakage.

Comment - Cull sawlogs are currently being harvested for use in the pulp mill. The high cost of barging may make this harvest uneconomic and thus result in a substantial volume loss.

13. Reliability.

Rafting - the system has proved very reliable.

Barging - reliability of land-to-land barging is unknown. ALP had a substantial equipment breakdown problem with a reliability factor of about 75%. Canada experience shows a substantial delay time over theoretical round trip time.

Comment - the barge system lacks the flexibility or options of the rafting system.

14. Ability to serve the purpose.

Rafting - it has a good record. Requires good production and storage schedule.

Barging - this ability is unknown. Would also require good production and storage scheduling.

Comment - it would seem foolish to supplant the rafting system without clear evidence of economic and environmental superiority of the barging system. It would be difficult to service the small operation. Furthermore, although

average tow distance is 100 miles, many tows are much shorter. On the other hand, there may be a place for limited water-to-water barging for long tows, and in certain waters during bad weather.

15. Energy requirements.

Rafting - relatively low requirements.

Barging - relatively high requirements, both in towing and in the related facilities and requirements.

Comment - this comparison is pertinent in view of the energy shortage being experienced in 1974.

B. Environmental Impact Factors

1. Effect on marine waters.

Rafting - localized BOD and low DO and some toxicity from leachates from bark and wood. There is not usually a significant water quality problem.

Barging - no usual problem but there would be increased exposure from oil spills from more machinery used.

Comment - log handling methods may be further improved to minimize loss of bark from logs - the main source of leachates. Further studies are planned to delineate extent of the problem, if any, and to recommend improvements in log handling methods. The adverse effects of logs in the water are not irreversible.

2. Effect on marine life.

Rafting - again, there is localized effect from smothering from bark accumulation and from grounding of logs in storage.

Barging - there may be a greater effect from fills on beach areas for bulkheads at loading sites. There is less flexibility in locating sites.

Comment - see above comments under marine waters. Good siting of dumps and good handling methods can minimize the effects of rafting operations.

3. Effect on upland environment.

   Rafting - little effect except where land storage areas have been or are being prepared with rafting to be used as the transportation mode.

   Barging - there would be a major effect since all logs would be stored on land at both loading and receiving points.

   Comment - we are so accustomed to changing the landscape that it is difficult to determine the effects on upland flora and fauna, except that the flora, being non-mobile, are destroyed. As heretofore mentioned, Schaumburg does not necessarily think that tradeoffs are in favor of land handling of logs.

4. Effect on aesthetics.

   Rafting - after termination of use, visual evidence may be minimized as land reverts back to nature.

   Barging - after termination of use a greater degree of visual evidence remains primarily because a larger area is disturbed in a more permanent way.

   Comment - assuming that any activity provides an impact on the environment, the nature and degree is highly personal. Some might say that either method is interesting if not beautiful.

C. Damage to Public Facilities

1. Aids to navigation.

   Rafting - according to the Coast Guard, incidents are few.

   Barging - according to the Coast Guard, there have been a few incidents attributed to chip barges.

   Comment - there appears to be little difference.

2. Boating and fishing.

   Rafting - again, according to the Coast Guard, incidents are few.

   Barging - effect is unknown but likely to be small.

   Comment - there appears to be little difference, although some drift logs will develop from rafting and some possibility of damage does exist.

SECTION VII

ECONOMIC ANALYSIS

A. Capital Costs

Basically, it can be said that barging is very capital intensive. Large sums of money would be involved in construction of barges, tow boats, loading and receiving facilities. The capital costs of barges and towboats are relatively well known, although costs are rapidly rising. However, the cost of loading and receiving facilities, including cranes or log stackers, are not known as there has been no experience in this regard on thecoastal water areas of Alaska, Canada and Washington. All evidence indicates that their direct cost will be very high and that the cost of associated facilities such as log storage areas and additional road requirement will be over that necessary for a rafting system.

Rafting, on the other hand, is not capital intensive. Dump sites, transfer points and storage areas do not require costly facilities. Rafting gear capital expense is related only to boomchains, anchors, and perhaps swifter wire. Receiving facilities, especially at pulp mills, are costly but are already in place. Towboats necessary for raft tows are not as large as those required for barges. Boyer Towing Co. states that the present capital investment in all tugs necessary to service the towing of rafts for KPC is ± $1,500,000 which is less than the cost of one tug and barge combination of the Kodiak Lumber Mills concept.

Under the present system of rafting, some land storage areas have been developed and thus would not require further development for barges. None of the dumping facilities would be suitable for use in loading barges.

B. Operating Costs.

Operating costs for rafting are low. There is a slight additional cost over normal log truck loading to achieve the desired sort. Strapping costs to create a log bundle from a truckload of logs are relatively low and no additional cost is incurred, in the case of truck logging, to make a bundle. A small cost is incurred in the case of A-frame or skidder logging. Marine equipment and raft making equipment required of the logger is of low capital and operating cost. Storage and towing costs are relatively low. Receiving equipment at the pulp mills for dry deck breaking of bundles is relatively expensive, but the operating cost, though not estimated herein, should be low. The requirements for energy are also low.

Barge operating costs are relatively high. Since capital costs are high, the depreciation rate per MBF will be high. Similarly, since the system is machinery intensive, energy and labor requirements are high.

Assuming an operating cost index for rafting in southeast Alaska waters on tows in the 100 mile range as 1, the index estimated for water-to-water barging would be in the 2 to 3 range, and the index estimated for land-to-land barging would be in the 3 to 5 range or more. As the tow distance increases, barging becomes more economical.

C. Summary of Estimated Costs for the Average Southeast Alaska Tow of Approximately 100 Miles.

Rafting	Estimated Cost
Non-towing costs, supplies, etc.	\$1.75/MBF
Towing costs	\$4.05-4.80/MBF
Additional costs of towing from water storage	\$0.60/MBF
Tow insurance	\$0.23/MBF
Dump and storage site cleanup and location change costs	\$0.05-0.25/MBF
Total	\$6.68-7.63/MBF

Barging (Land-to-Land)	Estimated Cost/Order of Magnitude
Extra access road required to reach suitable loading sites	1 to 5 miles at \$40,000 to \$60,000 per mile
Land storage requirement at loading point and loading dock facilities	2 to 8 times rafting requirement
Load, unload and tow operating costs	2 to 3 times rafting rate
Unloading facilities and storage area requirements at mill	5 to 10 times present facilities
Tow insurance	No change on logs
Log losses (assuming there is no casualty loss of loaded barges)	Savings of ± 20¢/MBF
Cleanup of barge	About same as cleanup of rafting dump and storage areas.

It is apparent from the above that in regard to key question No. 1, *"Is it more economical for the timber producer to transport logs by barging or rafting in southeast Alaskan waters?"*, the answer, assuming land-to-land barging, is overwhelmingly in favor of rafting. Assuming a form of water-to-water barging in which logs are removed from the water as carefully as logs are placed in the water for rafting, the cost would still be at least twice as expensive as rafting. Barging cost diminishes as tow distance increases, so that for a tow distance of 200 miles or more, direct costs are comparable and some benefit may be gained from barging by reason of a longer operating season.

D. Summary of Estimated Costs for Considerations Other Than Direct Costs.

Item	Rafting	Barging
Log losses	± 20¢/MBF	Usually none.
Volume losses	Insignificant	Possibly significant through diminished use of cull sawlogs for pulp because of high cost of barging
Stealing	Insignificant	None
Damage to the environment	Difficult of determine, but not really significant. By one measure, damage to commercial fisheries is estimated to be ± 30¢/MBF.	Difficult to determine. There may be damage to the upland environment as significant as that to the marine environment by rafting.
Damage to public and private facilities	Insignificant	Insignificant

In regard to key question No. 2, *"What costs of barging and rafting are external to the timber producer and are they sufficient to warrant the use of one system or the other?"*, the answer is that costs are difficult to determine and that they would not seem to significantly favor one system over the other. There have been comments by public and private environmentalists that great damage to the marine environment results from log rafting and that land-to-land barging will eliminate this damage. Yet studies made to date do not seem to support the claim that great damage results from log rafting activities, although it is clear that some damage local to dump and storage sites does occur. It is very difficult to quantify the extent of and to place a cost on such damage and no study made to date has done so. It is the conclusion of this study that in consideration of the relative values between marine and timber productions to the economy of southeast Alaska, the costs of damage from log rafting are insignificant. However, further study of the effects of log rafting on the marine environment are certainly needed. Since the economics of water transportation of

logs is clearly and decisively in favor of rafting, it is hoped that such studies will result in recommendations as to improved handling methods for log rafting.

E. Analysis and Summary

Forest Service data has indicated a rafting to barging cost ratio of 1 to 2 for a water-to-water barging system under Southeast Alaska conditions. This is approximately confirmed by Canadian cost experience. However, water-to-water barging does not satisfy adverse marine environmental impacts any more than does rafting. Therefore, if these impacts are to be avoided, land-to-land barging is necessary. The cost of such a system is not well known but is known to be much costlier than the barging systems now in use.

Is the value of adverse environmental impacts which may be alleviated by land-to-land barging less than or more than the additional cost of this barging system over log rafting? How does one measure these values? As Stokes (1974) states, "*One of the things that currently frustrates effort in this direction (that is, in the formation of criteria for a variety of public decisions related to water quality) is the absence of any good method of assessing the cost of water quality deterioration or alternatively, the benefit from water quality improvements.*" (Reference No. 65)

The conclusion in this study is that there are some adverse effects on the environment from rafting, but that they are localized at the impact point and their magnitude is small. Further, that with continued improvement of log handling methods in marine waters and cooperation of the industry, these impacts can be further reduced.

It should also be clear that there would be adverse impacts on land environments in the event that land-to-land barging is required. Schaumburg has stated that, in an Oregon study in regards to sorting and storage of logs, adverse environmental impacts from dry land handling exceeded those from water handling.

To summarize and put in perspective, it seems clear that the cost of land-to-land barging would be three or more times that of the present rafting system in use in southeast Alaska. Assuming an average cost of $7.00/MBF for an average rafting tow of 100 to 110 miles, this means that land-to-land barging would cost a minimum of three times that or $21.00/MBF or more. The relevant question to ask at this point would be, is the avoidance of possible adverse environmental impacts from rafting worth that difference, $14.00/MBF or more? Or, based on an annual production of 600 MMBF, would it be worth $8,400,000 or more per year?

If the industry were required to move logs by land-to-land barge instead of by rafting, production costs would increase. This would result in lower bids on stumpage and lower receipts to the Forest Service. The cost of a barging requirement, then, would be borne by the timber owners, the people of the United States.

Until 1974, the margin between stumpage paid and minimum stumpage price required by law was about $4.00/MBF. Other sale requirements which may be imposed on the industry would lower that margin even more. It is apparent that there is not sufficient margin in the stumpage to support a land-to-land barging requirement. If one were imposed, the industry would feel the economic implications and discontinue operations if profitable operations were no longer possible. To say the least, this would be undesirable from the standpoint of employment and community stability.

There appears to be no environmental or economic reason to supplant log rafting with land-to-land barging. There is need for additional study on the effects on the marine environment of log rafting and storage. Several government agencies have plans to do such studies which may result in recommendations for improved water log handling practices. There is a possibility that limited water-to-water barging, which would extend the transportation season on some waters such as Chatham Straits and Lynn Canal, may prove to be economically desirable. Again, careful handling would be required to minimize environmental impacts. As Stein, in another but similar context said, *"It is good to pause and mend the environmental shortcoming in our present practices. But let's build on existing knowledge and experience, not scrap ongoing practices because they need some improvement or are politically unpopular. Crash shifts into untried alternatives are not likely to help us reach . . . goals faster, but they are certain to increase total costs and waste both time and effort."* (Reference No. 63)

APPENDIX 1

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